



**Quarterly Progress Report**

**Grant #7310006**

**Arctic Thermal Shutters and Doors**

**Arctic Sun, LLC**

**April 15, 2013 through June 30, 2013**

**Deliverables Submitted:** The final designs and drawings for the Arctic Shutter and Arctic Door were submitted on April 30<sup>th</sup> and are attached here (Task 1). The completed data collection plans and drawings for the testing box and project instrumentation are also attached (Task 3). The blown-in shutter design is in the final stages of completion, and will be filed soon (Task 2).

**Budget:** No invoices were submitted previously for reimbursement; however, an advance payment of \$34,000 was requested and granted. Attached is a reimbursement form with back-up for all of the expenditures through June 30<sup>th</sup>, totaling \$33,069.37. The majority of the expenses were for labor to design, build and test a variety of prototype models and components. \$10,568.81 was expended on various parts and supplies to construct these test models. All of these expenses are summarized on the attached Excel spreadsheet titled "Grant report 6302013." These figures indicate we are on pace to complete the first three tasks very close to the \$41,000 budget.

**Schedule Status:** Arctic Sun has been busy with the peak of our installation season, and consequently, we are still a bit behind schedule with the finalization of the blown-in shutter design. The process has also been complicated by trying to source appropriate insulation beads. We have resolved the sourcing issue, and now expect the design to be completed within the next couple weeks.

**Percent Complete:**

Task	Start Date	End Date	Deliverables	Percent Complete
Complete ridged shutter and door design	Jan 2013	April 2013	Design Plans	100%
Complete Blown-in shutter design	Jan 2013	May 2013	Design Plans	75%
Develop plans for testing box and project instrumentation	Jan 2013	May 2013	Testing box design and performance monitoring plans	100%

**Work Progress:**

**Task 1. Ridged shutter and door design;** The final designs were submitted previously (and are attached) and after approval, staff is ready to move on to the next milestone.

**Task 2. Blown-in shutter design;** We tested a variety of different products for use as the insulating beads for this shutter. The specific traits and performance of the beads dictates many of the other design parameters, so resolving this issue first was paramount. We tested and compared many different materials, including expanded and raw-resin polypropylene, expanded and raw polystyrene, shredded polyurethane, high density polyethylene, EPDM, neoprene, nylon and Teflon. We also experimented with various sized material ranging from 2mm to 10mm, including hollow and solid samples.

We evaluated each product's ability to be blown; production of static; ability to be vacated from the cavity; UV stability; R-value; availability; and cost. Our final choice was to utilize short cylindrical beads of solid expanded polystyrene (EPS) 9mm in diameter and 6mm long (photo below). These beads are inexpensive, readily available and perform exceptionally well in all parameters tested.



We are still performing a UV stability test with the EPS beads. The beads were loosely placed within a small glass-sided box, as they would be blown into a cavity utilizing the final design. This window was then placed outside on June 28<sup>th</sup>, facing south with full exposure to the sun (photo below).



We'll leave this in place all summer and document any changes to the beads as a result of this solar exposure. As of July 24<sup>th</sup> there were no significant changes noted.

With the superior performance of the EPS beads in almost all tests, we are satisfied they are the best product for this shutter application. Beads of smaller dimensions tended to produce more static and proved more difficult to vacate from the void. The photo below illustrates severe static cling with black beads stuck all over the glass, failing to vacate the test chamber.



Currently, we are testing different ducting and control systems. The biggest challenge appears to be developing an inexpensive but reliable automatic shut-off sensor/switch. Manual operation of the system is possible, but ease of operation, safety and marketability warrant an automated system if at all economical.

**Task 3. Develop plans for testing box and project instrumentation;** Arctic Sun worked closely with ACEP and incorporated all of their suggestions in our Data Collection Plan. This included the test box design and the instrumentation selection to achieve acceptable levels of accuracy.

We are confident this approach will provide us with valuable quantification of the performance of the units. The plan and drawings are attached.

**Future Work:** The near-term priority is for staff to complete the blown-in shutter design, and specifically the automated shut-off system. As soon as the designs are approved, we will begin construction of the test box and some shutters and doors for installation in test locations as the sites are identified. We are not expecting any significant problems with this process.